Global Economics Analyst

Upgrading Our Longer-Run Global Growth Forecasts to Reflect the Impact of Generative AI (Briggs/Kodnani)

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- Earlier this year, we estimated that the efficiency gains promised by generative artificial intelligence (AI) could provide a significant boost to global labor productivity. While considerable uncertainty remains about the timing and magnitude of AI's effects, our baseline expectation is that generative AI will affect productivity within our ten-year forecast horizon. We are therefore upgrading our global GDP forecasts from 2027 onwards to incorporate the impact of generative AI.

- Productivity gains map one-to-one to GDP if workers are not permanently displaced and the capital stock increases to match productivity improvements, so—if taken at face value—our baseline estimates would imply a 10-15% cumulative long-run boost to GDP globally. In practice, the net effect of generative AI on GDP is likely to be smaller for two reasons.

- First, if viewed as the "next wave" of technological innovation, the growth impact of generative AI may not be fully additive to the current GDP trend. Information and communication technology (ICT) has recently driven almost half of labor productivity growth in DM economies—reflecting both increased ICT investment and complementarities with existing inputs—so some AI-related gains may substitute for growth that would otherwise occur in a non-AI baseline.

- Second, underlying productivity growth has slowed, with recent research suggesting that near-term total factor productivity grows linearly, with an occasional step-up following technological regime shifts, rather than exponentially. Unless AI ushers in a new productivity growth regime—an outcome that is possible but premature to forecast—the boost we anticipate from generative AI may be partially offset by an underlying growth slowdown.

- In addition, barriers to adoption may delay productivity growth even if the full efficiency gains we see as possible are ultimately realized. Based on historical productivity gains following technological breakthroughs, commentary from business leaders, and cross-country technology adoption patterns, we anticipate that any GDP growth boost won't exceed 0.1pp until 2027 in the US, 2028-2032 in other DMs and advanced EMs, and 2034 or later in other EMs.

- Nevertheless, the enormous economic potential of generative AI suggests

growth upside even after taking these offsets into account. In the coming weeks, we will therefore raise our growth forecasts in the second half of our ten-year forecast horizon as part of our 2024 outlooks, including by 0.4pp in the US, by 0.2-0.4pp in other DMs, and 0.1-0.2pp in advanced EMs by 2034.

Upgrading Our Longer-Run Global Growth Forecasts to Reflect the Impact of Generative AI

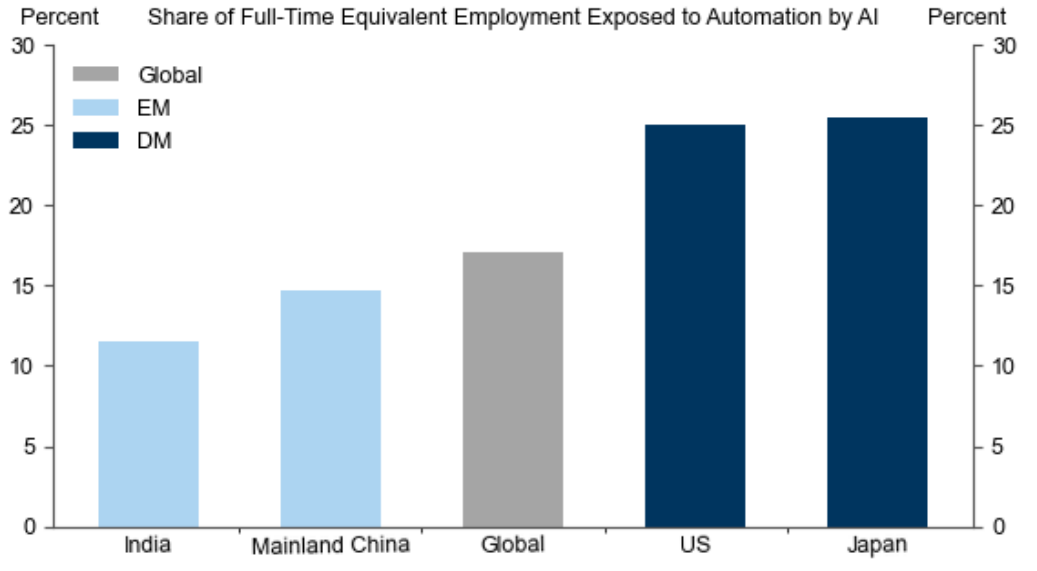
This year, a major focus of markets and commentators has been the disruptive potential of generative artificial intelligence (AI) to automate work, spur innovation, and drive economic growth. We have argued that AI has the potential to disrupt global labor markets and drive large productivity gains, and have subsequently shown that this process could drive a capital investment cycle with both short-term and long-term consequences for financial markets.

While considerable uncertainty remains about the timing and magnitude of AI's effects, our baseline expectation is that generative AI will have a measurable macroeconomic impact within our 10-year forecast horizon. In this *Global Economics Analyst,* we therefore extend our work on the economic potential of AI—as well as related trends in productivity growth and technology adoption—and ultimately propose a set of AI-driven upgrades to our global GDP forecasts through 2034 that we will incorporate in our 2024 outlooks in the coming weeks.

The Enormous Economic Potential of Generative AI

The foundation for our view that AI can drive a meaningful acceleration in global growth is our finding that AI models have the potential to automate a large share of current work. Using detailed data on the task content of 900+ US occupations—and extending to other countries using data on the employment composition of various economies—we estimate that generative AI could ultimately automate roughly 25% of work tasks in major DMs and 10-20% of work in EMs (Exhibit 1).

Exhibit 1: A Large Share of Work Is Exposed to AI-Driven Automation

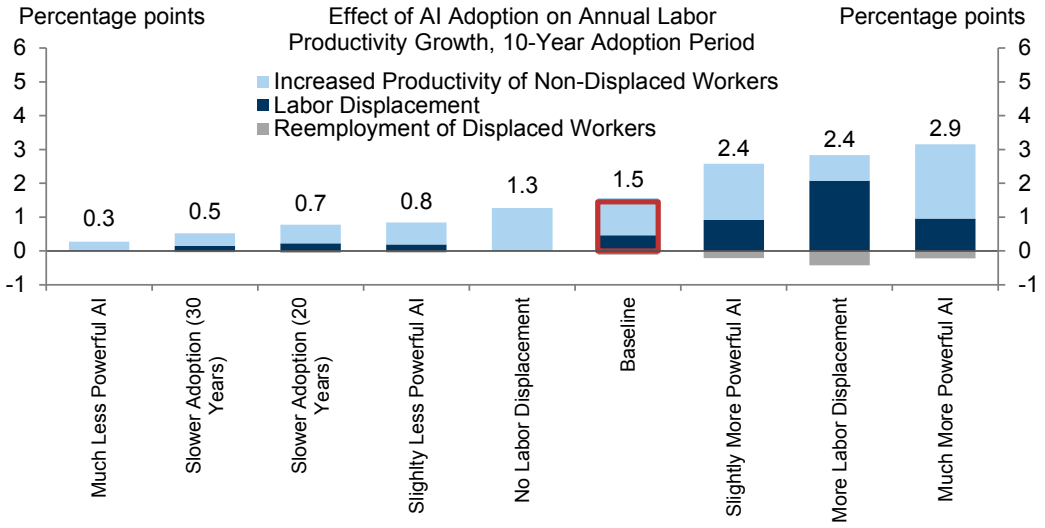


Source: Goldman Sachs Global Investment Research

In turn, we expect this automation to drive labor cost savings and free up workers' time, some of which will likely be allocated to new tasks. While the estimated size of these

effects varies considerably depending on the ultimate capabilities of AI and how the technology is implemented, we expect the impacts on productivity to be meaningful across a wide range of scenarios (Exhibit 2). In our baseline scenario, we estimate that AI could contribute 1.5pp to annual US productivity growth if widespread adoption were achieved over a ten-year period.

Exhibit 2: The Scale of the Productivity Boom Is Potentially Large but Uncertain

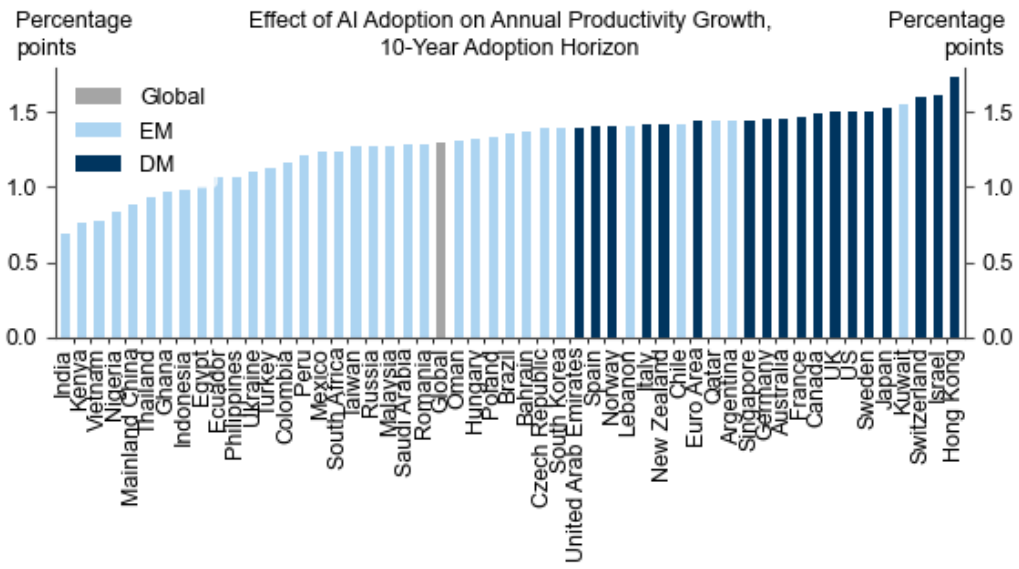


Source: Goldman Sachs Global Investment Research

We have extended our estimates of this productivity upside to all of the countries in our economics research coverage based on country characteristics such as the sectoral composition of GDP, income per capita levels, and relative education levels.[1] These estimates imply that, given the same 10-year adoption timeline, AI would have similarly large productivity effects to the US in other major DMs, and somewhat smaller effects of 0.7-1.3pp in most EMs given their higher share of total employment in sectors with low AI exposure such as agriculture and construction (Exhibit 3).

[1] In our original report, we combined our detailed occupational exposures into sector-level AI exposures, then extended them to a wider set of countries using the Groningen Growth and Development Center's Economic Transformation Database (which standardizes the sectoral composition of employment across several DM and EM economies). We also conservatively assumed that AI would not boost agricultural productivity in EMs. In this report, we extend those estimates to all countries in our economics coverage using a regression model which predicts country-level AI productivity exposure using GDP per capita, the services share of GDP, the agriculture share of GDP, adult literacy rates, and whether the country is a DM or EM economy. This model predicts over 80% of the variation in our original country-level estimates.

Exhibit 3: We Estimate a 1.3pp Boost to Global Productivity Growth Over a 10-Year Horizon



Source: Goldman Sachs Global Investment Research

Taken at face value, these estimates imply substantial upside to GDP growth over coming decades. Conceptually, economywide productivity gains map one-to-one to GDP if workers are not permanently displaced (i.e., new jobs are created) and the capital stock increases to match productivity improvements, both of which have typically held over long spans of time. This suggests that our baseline estimates would be consistent with a 10-15% cumulative long-run boost to GDP globally. In practice, however, we think the net effect of generative AI on GDP is likely to be smaller for two reasons.

The Next Wave of Technology-Driven Automation

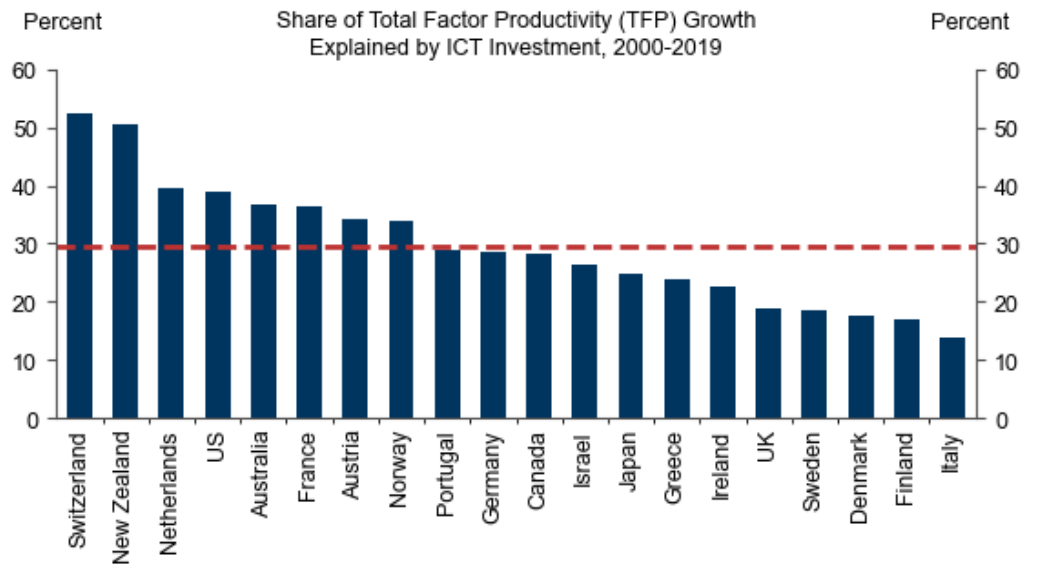
The first reason is that continued technological progress is already built into existing estimates of trend growth. If generative AI is the "next wave" of technological progress—or if investment in AI crowds out other technology investment—then simply adding our estimated productivity growth boost to the current trend would likely result in some double counting. We are especially cautious about treating the growth boost from generative AI as fully additive because information and communication technology (ICT) investment has already been the main driver of productivity growth in major economies over the last 20-30 years, with effects coming via two channels.

First, ICT capex has outpaced growth in labor and other types of capital for the last few decades. The OECD estimates that investment in these technologies has accounted for 30-40% of all labor productivity growth in DM economies from 2000-2019.

Second, ICT investment may also have indirectly driven growth in total factor productivity (TFP)—the residual growth in productivity not identified by any single input—through its unusually large complementarities with other production inputs (e.g., the use of digitization and data to improve the efficient use of machinery). To estimate how much ICT investment has raised TFP, we estimate a cross-country panel regression that tests whether ICT investment predicts TFP growth over five-year periods, controlling for lagged TFP growth and country fixed effects for 23 economies.

Our estimates imply a small but statistically significant effect, with each 1% increase in ICT investment raising TFP growth by .03pp. Given the rapid pace of ICT investment growth (over 10% per year for countries in our sample from 2000-2019), however, ICT investment actually explains a notable share of TFP growth in most countries, and roughly 30% on average (Exhibit 4).

Exhibit 4: ICT Investment Is Associated with Higher TFP Growth

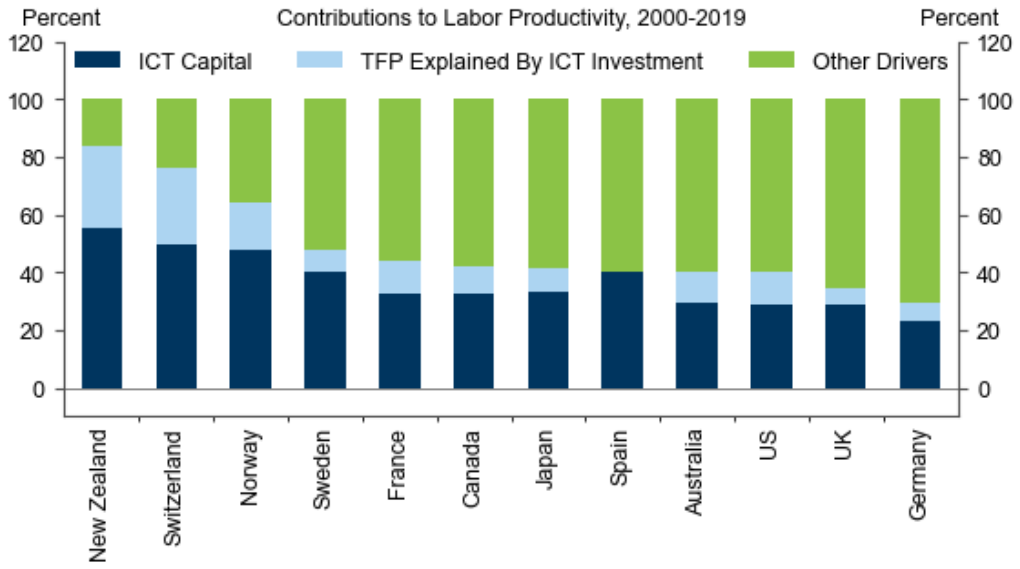


Source: Goldman Sachs Global Investment Research

As Exhibit 5 shows, combining our estimates of ICT's direct and indirect contributions suggests that almost half of all labor productivity growth over the last 20 years can, on

average, be attributed to advancements and investment in ICT.

Exhibit 5: Advances and Investment in ICT Have Driven 40% of Labor Productivity Growth Since 2000, and May Partially Overlap With Our Productivity Growth Estimates



Source: OECD, Goldman Sachs Global Investment Research

While the extent to which AI-related productivity gains might overlap with other technological advances is admittedly uncertain, our analysis suggests significant scope for some AI-related productivity gains to substitute for rather than add to the underlying growth trend.

A Slowing Ex-AI Productivity Growth Trend

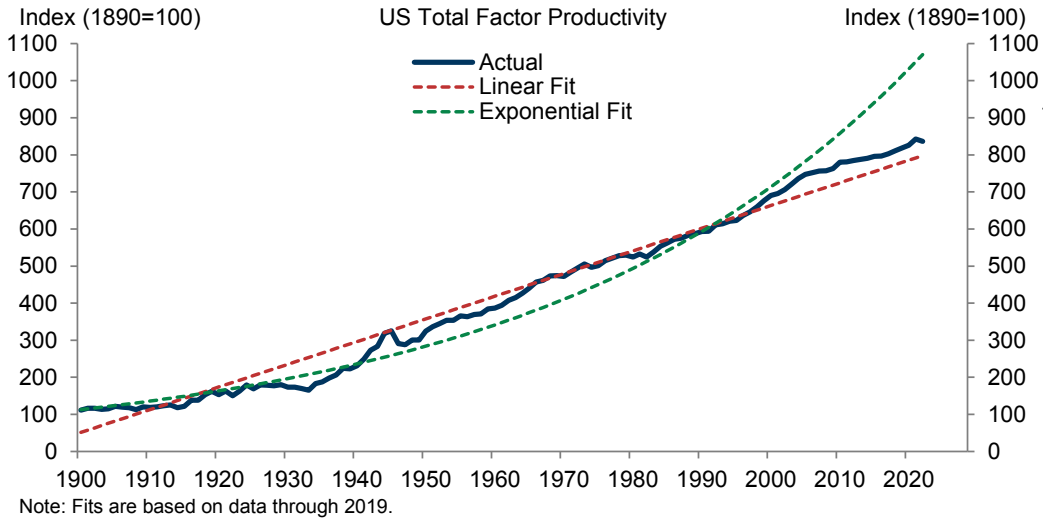
The second reason why we are cautious that generative AI will raise growth by as much as our baseline estimate is that the underlying productivity growth trend has been slowing and would likely continue to do so in a non-AI counterfactual.

As our US economics team has noted, recent academic research from NYU economist Thomas Philippon argues that TFP growth is best modeled as a linear rather than exponential process. That is, new ideas and technologies *add to* rather than *multiply* the stock of knowledge used for economic production, or equivalently, the marginal impact of new innovation is independent of pre-existing technologies. Under this theory, the rate of TFP growth would naturally slow over time, since roughly constant incremental gains in any given year would become relatively smaller as the stock of knowledge and technology increases.

It is fairly easy to imagine examples that argue for both linear and exponential growth. On one hand, there is little reason to believe that the invention of a typewriter would drive more incremental value today than it did in the 1920s (after controlling for aggregate labor and capital). On the other hand, advances in computing likely amplify the effectiveness of existing technologies, consistent with multiplicative growth.

The correct model of TFP growth is therefore ultimately an empirical question, and after replicating Philippon's work, our US team concluded that a linear trend better explains US data over the last 100 years, as illustrated in Exhibit 6. Replicating these results in a set of statistical analyses for other countries confirms that a linear trend better explains total factor productivity growth.

Exhibit 6: A Linear Model Provides a Better Statistical Fit of Productivity Growth Over Recent Decades

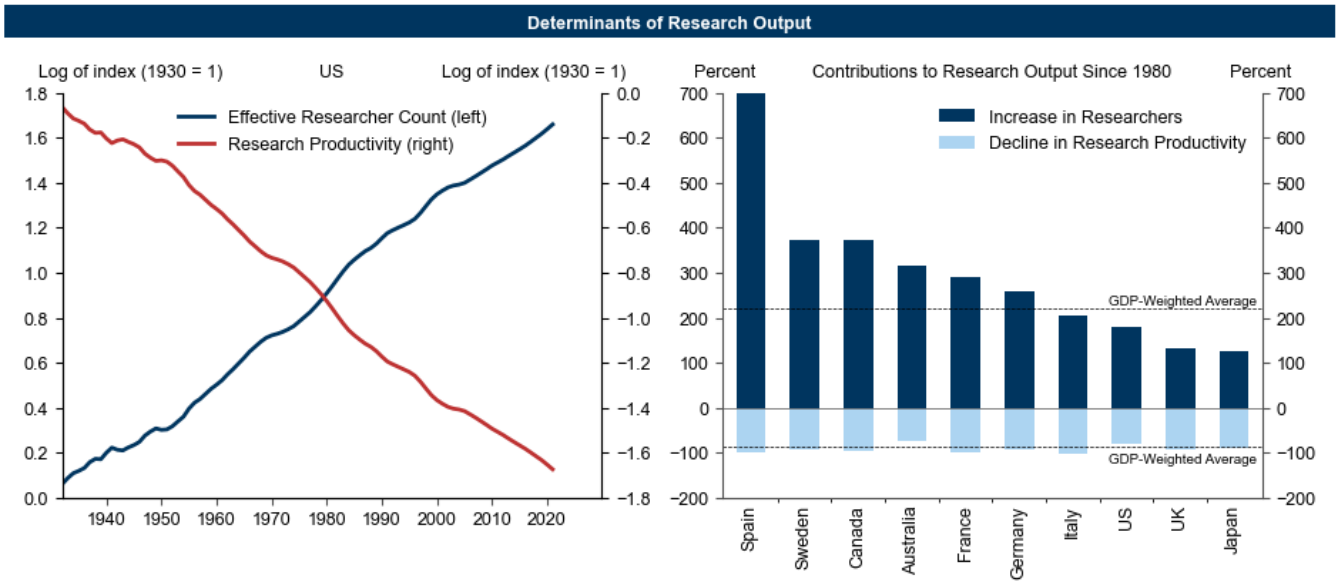


Source: Bergeaud, Cette, and Lecat (2016), Goldman Sachs Global Investment Research

Based on this empirical evidence, we conclude that a linear TFP growth model will likely yield better near-term forecasts, implying roughly 0.1-0.2pp of downside to TFP growth over the next 10 years.

One way to reconcile this finding with the intuition that some technologies *can* have multiplicative effects on productivity is the theory that, following major technological breakthroughs, businesses and researchers first harvest the easiest gains, after which incremental idea generation and technological progress becomes more difficult over time. Indeed, Stanford economist Chad Jones and coauthors[2] have shown that this theory empirically explains the observed productivity growth slowdown in advanced economies. As Exhibit 7 shows, research efficiency (defined as TFP growth per researcher) has declined steadily over the last 100 years even as R&D efforts have increased rapidly.

Exhibit 7: The Observed Slowdown in Productivity Growth May Be Explained by Decreasing Returns to R&D

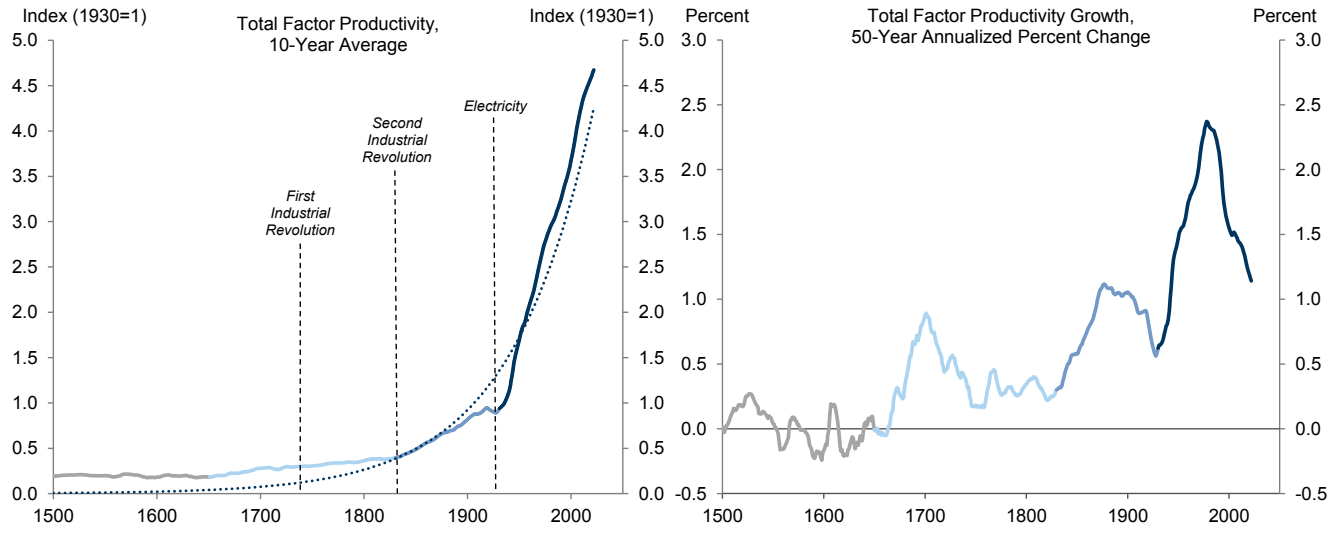


Source: Jones et al. (2020), Goldman Sachs Global Investment Research

Both Jones and Philippon agree that for a sustained increase in labor productivity growth to occur, a new transformative technology needs to emerge that facilitates an increased pace of technological progress and efficiency gains. Combining GDP per capita—which serves as a proxy for TFP when hours worked per capita and the capital share are approximately constant—from the UK prior to 1900 with TFP data from the US since then, Exhibit 10 shows that there have been three structural breaks in productivity growth since 1500: one just before the first industrial revolution in the 1600s, a second around the second industrial revolution in the mid-1800s, and a third after the emergence of electricity in the early 1900s. In each of these instances, productivity growth accelerated for an extended period before fading after initial efficiency gains were exhausted.

[2] Bloom, Nicholas, Charles I. Jones, John Van Reenen, and Michael Webb. "Are ideas getting harder to find?." American Economic Review 110, no. 4 (2020): 1104-1144.

Exhibit 8: Long-Run Productivity Data Points Toward an Initial Jump and Subsequent Slowdown Following Technological Breakthroughs



Source: Maddison Project Database, Haver Analytics, Goldman Sachs Global Investment Research

A natural question is therefore whether generative AI could be a paradigm-shifting technology that ushers in a new productivity growth regime.

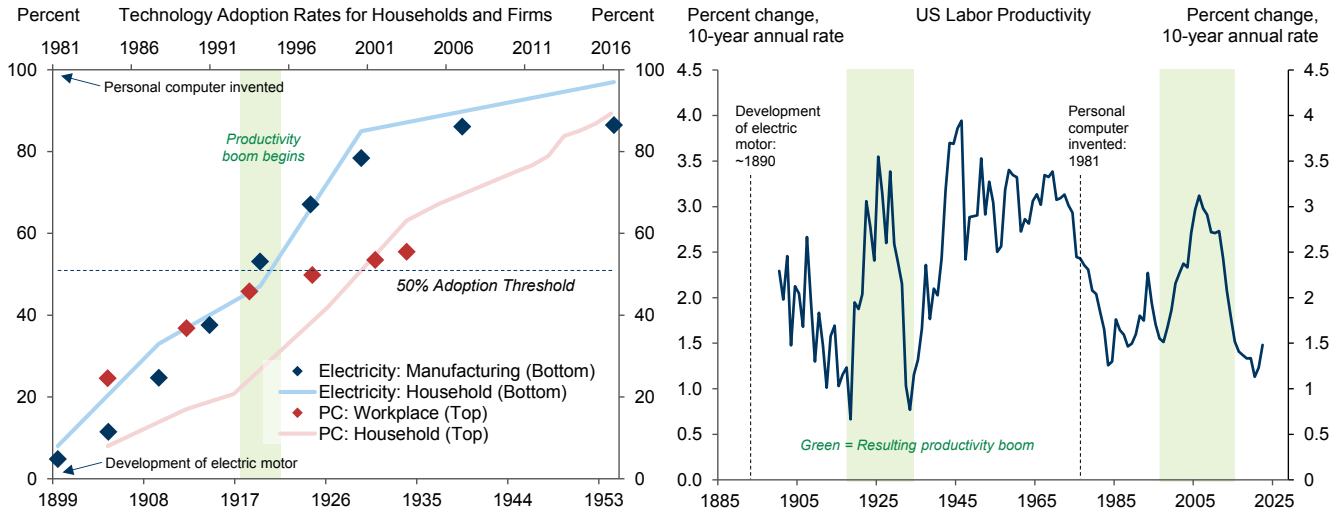
Many commentators believe this is a possibility, particularly if generative AI models progress to a point where they are able to innovate on their own and accelerate the pace of idea generation. Indeed, our equity analysts have highlighted several areas where this may be possible in the foreseeable future, including in healthcare and drug discovery, cybersecurity, design, and software development. Furthermore, some commentators view recent advancements in generative AI models as a meaningful step towards a "superintelligence" that is able to process information, formulate views, and innovate beyond the capability of humans.

For now, we see such predictions as very premature, especially given the well-documented limitations of current AI models, including a tendency to "hallucinate" false information. We therefore maintain our view that for the foreseeable future, generative AI will mostly drive efficiency gains by automating less difficult but time-consuming tasks, thereby empowering workers to engage in more productive activities. Under this assumption, the impact of generative AI should more than offset the empirically-validated productivity growth slowdown that would likely prevail in a non-AI baseline, but will provide a transitory rather than permanent boost to growth.

A Cautious Adoption Outlook

An additional factor we consider when estimating the growth upside from AI is the adoption timeline for the technology, as the full extent of the productivity upside we cite is contingent on widespread adoption. As Exhibit 9 shows, productivity booms driven by prior milestone technologies—such as the electric motor and personal computer—have historically lagged the initial innovation by over a decade, and only began to show up in macroeconomic data once roughly half of affected businesses had adopted the technology.

Exhibit 9: Productivity Gains Tend to Lag Technological Breakthroughs

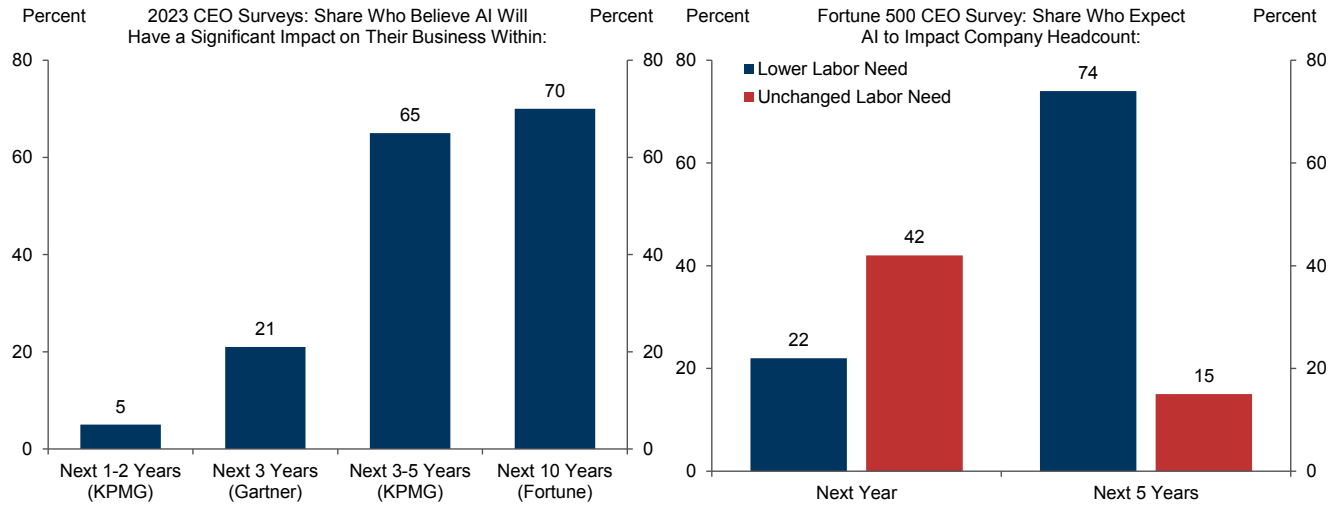


Source: US Bureau of Labor Statistics, Census Bureau, Our World in Data, Woolf (1987), Haver Analytics, Goldman Sachs Global Investment Research

We have been relatively cautious on the AI adoption timeline and expect the growth boost from AI to be delayed—and more drawn out—relative to our stylized ten-year estimates. While a rapid acceleration in AI-related investment is ongoing for leading technology and professional services firms which are developing and pioneering the use of AI, the effects on productivity that we have estimated will require the implementation of AI across a broader set of industries and job functions.

In the US, we expect such broad-based adoption to accelerate beginning in the second half of this decade. In support of this view, surveys of businesses and executives generally anticipate a small impact on activity and hiring needs in the next 1-3 years but a much larger impact in the next 3-10 years (Exhibit 10).

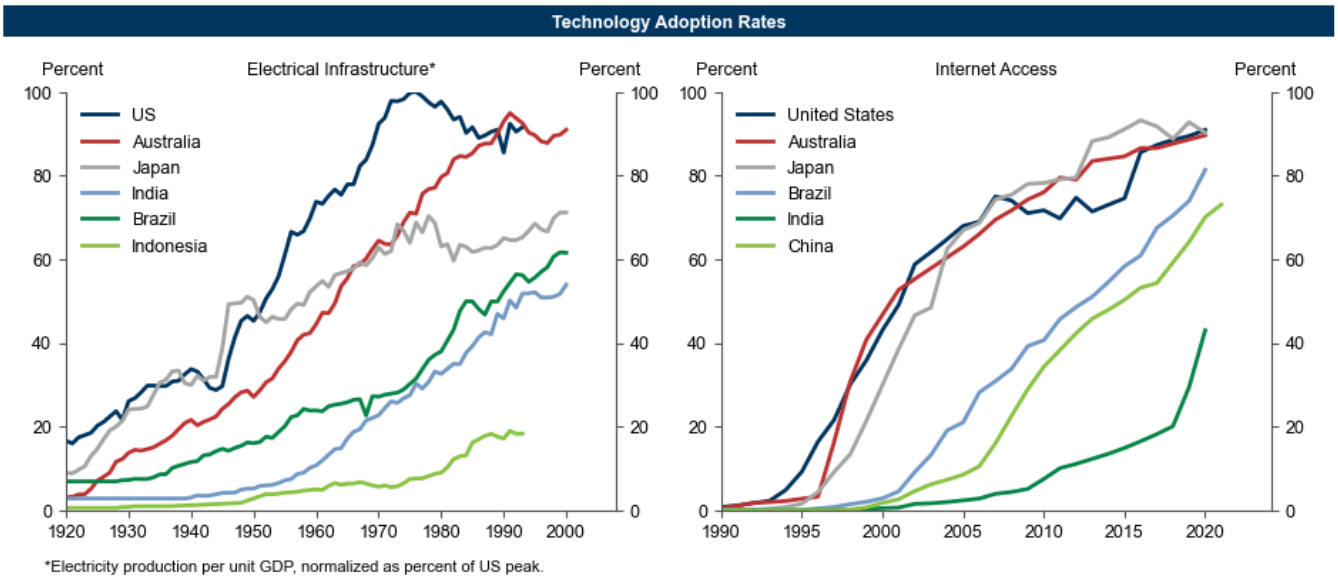
Exhibit 10: Business Leaders Expect a Somewhat Slow Adoption



Source: KPMG, Gartner, Fortune, Goldman Sachs Global Investment Research

The adoption timeline is likely to be even more drawn out elsewhere, as the US and other advanced economies have historically led in the adoption of milestone technologies relative to their EM peers (Exhibit 11). The extent of these lags varies considerably depending on the technology—in the case of the internet, major DMs' adoption tracked rather than lagged that of the US, and EMs' adoption lagged DMs by ~15 years rather than the 2-4 decade lags of electrical infrastructure.

Exhibit 11: Technology Adoption Rates Vary Widely, but DMs Consistently Lead EMs

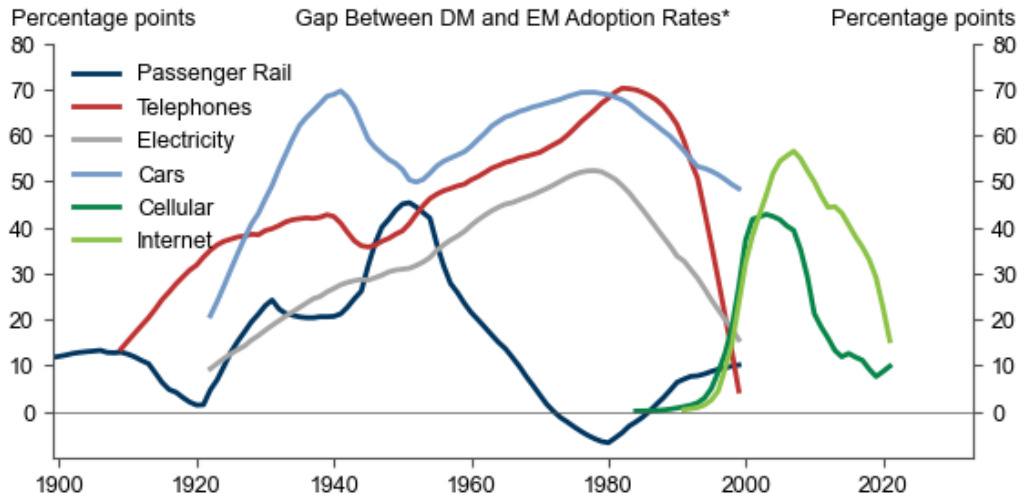


Source: Comin and Hobijn (2009), Our World in Data, Goldman Sachs Global Investment Research

As Exhibit 14 shows, the long historical record confirms that EM technology utilization—per capita or per unit of real GDP—does eventually converge to similar levels as DMs, but the gap between DMs and EMs can be large and persist for decades. Such lags, however, appear to have declined over time—particularly for ICT-related technologies—consistent with still-low barriers to cross-border goods and information trade by

historical standards.

Exhibit 12: The Absolute and Relative Gap Between DM and EM Adoption Rates Has Been Shrinking



*For technologies where utilization is measured in quantities (e.g., passenger rail kilometers traveled), adoption is measured as the quantity divided by real GDP. Gaps shown as percent of peak DM adoption.

Source: Comin and Hobijn (2009), Our World in Data, Goldman Sachs Global Investment Research

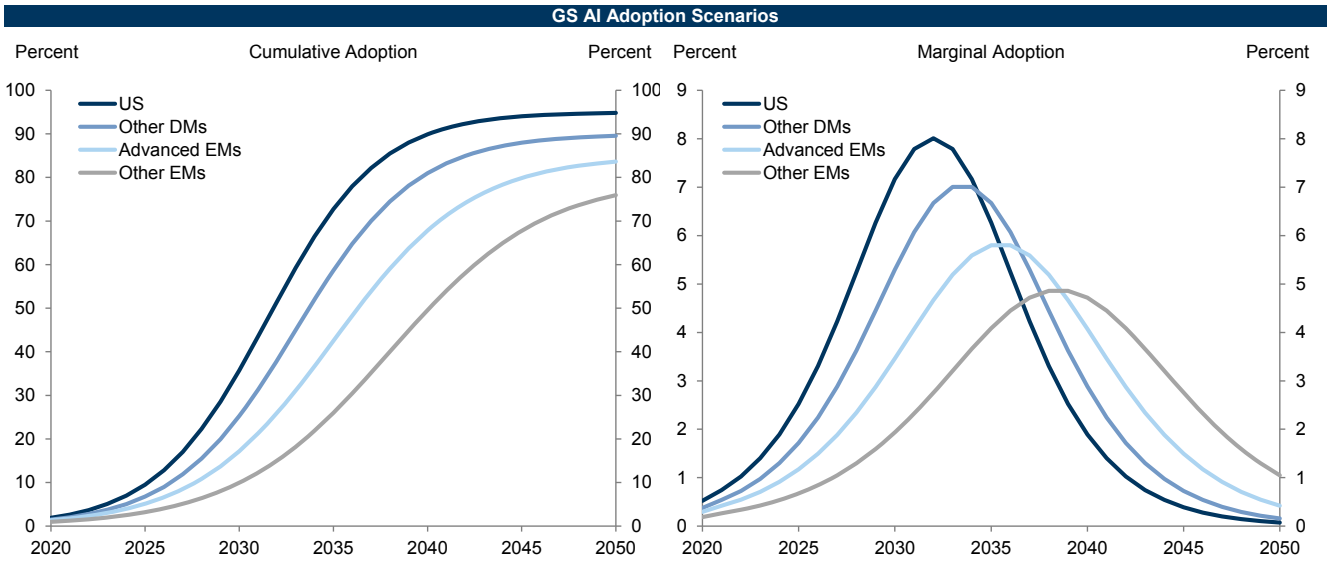
To model scenarios for AI adoption across countries, we combine 1) survey information about AI adoption trends in the US, which we expect to be the market leader, 2) assumptions about adoption lags of other countries relative to the US, and 3) details on country-level institutional characteristics. Specifically, we make the following assumptions:

- 10% of US firms will adopt generative AI by 2025, with firms in other DMs and advanced EMs (e.g., China, Brazil) closely following in 2026 and 2027. We expect firms in other EMs to lag further, reaching 10% adoption in 2029.
- We estimate (based on calibration to recent ICT adoption rates, and assuming moderate further declines in adoption lags) that it will take 13 years for the middle 80% of adopting US firms to incorporate AI, and slightly longer intra-country adoption lags of 14, 16, and 18 years for other DMs, advanced EMs, and other EMs respectively.
- The terminal rate of adoption (as a share of economywide firms that have some exposure to AI) will range from 80-95%, with the US on the high end and other EMs on the lower end.

Combining these estimates implies that the US will likely reach a 50% AI adoption rate by 2031-32, followed by other DMs in 2033, advanced EMs in 2035, and other EMs in 2038 (Exhibit 13, left panel). The rate of marginal AI adoption is also likely to peak around this time (Exhibit 13, right panel), and we assume that the ultimate growth boost from AI will take a similar "bell curve" shape to the rate of marginal adoption (although we assume that the productivity impact within any marginal firm adopting AI is realized linearly over 5-10 years—with a slightly longer lag in Europe to reflect likely regulatory

frictions that may initially limit use cases—consistent with existing research[3] on intra-firm lags on the realization of productivity gains from new technology).

Exhibit 13: Our Stylized Scenarios Suggest that the Marginal Rate of AI Adoption Will Accelerate to its Peak in the 2030s



Note: Adoption rates shown as a share of economywide firms exposed to AI automation.

Source: Goldman Sachs Global Investment Research

[3] Brynjolfsson, Rock, and Syverson (2021). "The Productivity J-Curve: How Intangibles Complement General Purpose Technologies." American Economic Journal: Macroeconomics, Vol. 13, No. 1, pp. 333-372. https://www.aeaweb.org/articles?id=10.1257/mac.20180386

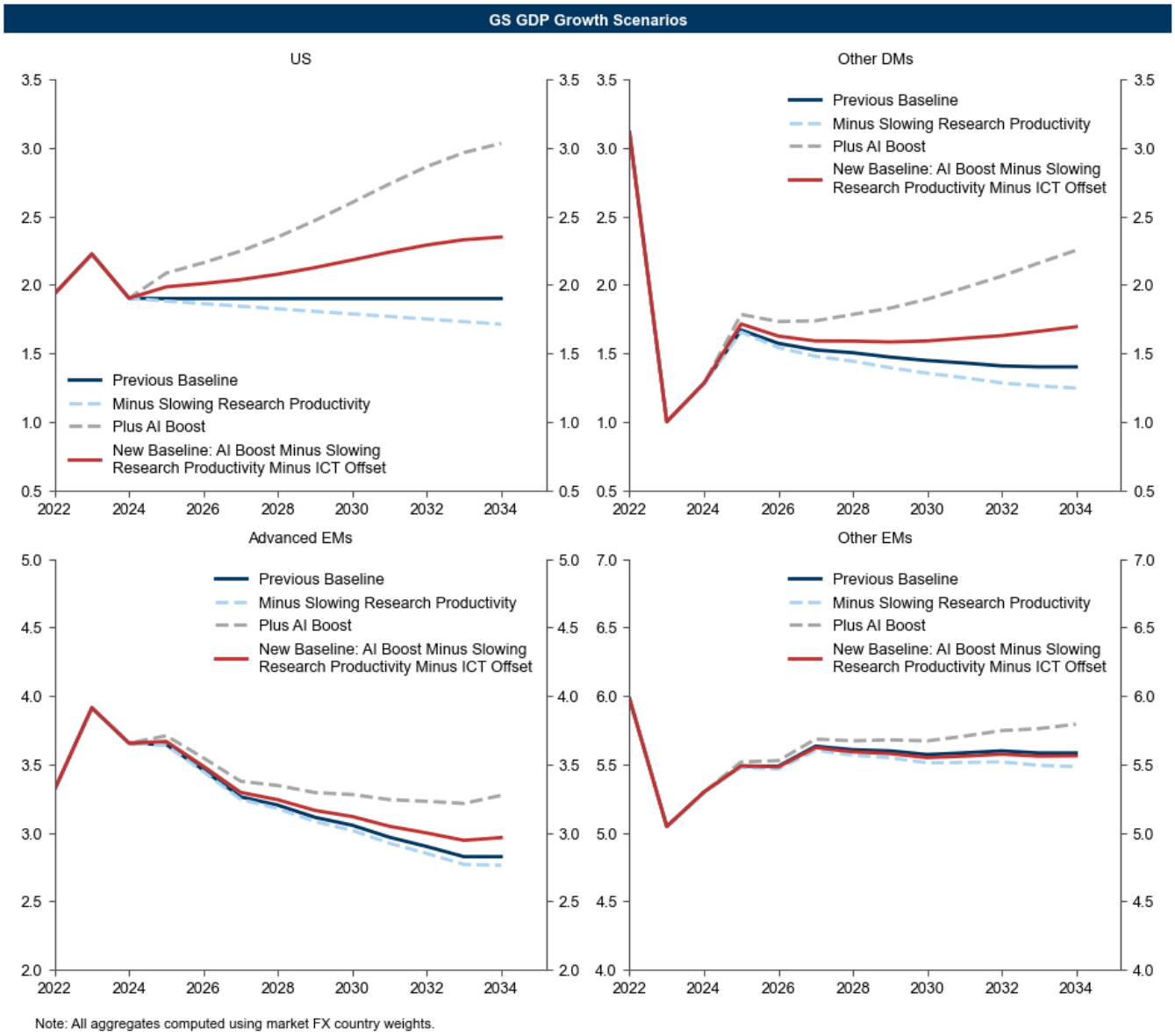
Updating Our Longer-Run Global Growth Forecasts

Lastly, we combine our estimated AI growth boosts with the aforementioned offsets from the displacement of other ICT investment and slowing research productivity and our stylized adoption scenarios to estimate the upside to GDP growth relative to our current forecasts. Specifically, we assume the following:

- In a counterfactual without AI, growth will slow linearly through the end of our forecast horizon, on average by 0.15pp across economies (the rate of slowing in the year-over-year growth rate over the next decade that would be implied by a locally linear, rather than exponential, total factor productivity trend).
- The cumulative *level* boost to productivity that we have estimated from AI will be fully realized, but not necessarily over 10 years. For example, if we estimate a 1pp boost to productivity growth over 10 years, that implies a roughly 10% increase in productivity levels, which could instead realize as a (10/N)pp boost to productivity growth over any number of N years.
- However, this level boost will be offset by a full replacement of the ICT contribution to productivity growth for all of the years in which AI adoption is increasing from 10% to 90% of its terminal level (13-18 years, depending on country). Continuing with the above example, if ICT contributes 0.2pp to annual growth, and increasing adoption from 10 to 90 percent takes 15 years, we would subtract 3% from the cumulative level boost from AI, and distribute the remaining 7% upside to productivity levels over the adoption timeline we have estimated.
- As noted in the previous section, we distribute the overall GDP increase from AI over our forecast window based on the marginal adoption timeline of AI, but accounting for an additional intra-firm lag of 5-10 years for productivity gains to realize.

In Exhibit 14, we report the results of our model. Our estimates suggest that the boost from AI will meaningfully outweigh the otherwise slowing productivity trend in most economies in our economics coverage through the end of our forecast horizon. Specifically, we estimate a growth boost of 0.4pp in the US, 0.3pp on average in other DMs, and 0.2pp on average in advanced EMs by 2034. In other EMs, we expect the boost from AI to be smaller given a more delayed adoption timeline and a lower AI exposure, and thus expect the ultimate impact to roughly offset that of slowing research productivity, leaving average growth rates unchanged over the next decade.

Exhibit 14: After Accounting for Offsets, We Expect a Moderate Boost to GDP Growth in the US and Other DMs and a Smaller Boost to Advanced EMs in the Second Half of Our Forecast Horizon



Source: Goldman Sachs Global Investment Research

While our model confirms that AI is likely to have a positive macroeconomic impact over the next decade, it also suggests that such an impact is unlikely to be meaningful this cycle. Indeed, we do not estimate any country-level growth boost in excess of 0.1pp until at least 2027, and—given that our country economists have modeled medium-term cyclical growth in far more detail—we are therefore leaving our forecasts unchanged until at least 2027 for the US and 2028 for other economies (see Appendix for all forecast changes). These changes will be incorporated into our official forecasts when we publish our 2024 outlook in the coming weeks.

While our base case is for a moderate global growth effect over the next decade, we emphasize that the risks around these estimates are large. On the positive side, our model implies positive (and in most cases increasing) growth contributions from AI through at least 2040, so shorter adoption lags (especially for EMs) could raise the

growth impact before then. Additionally, if AI displaces only a subset of ICT investment (e.g., non-AI software but not robotics), or if AI accelerates the production of ideas in other fields (and thus research productivity) through its generative capabilities, growth effects could be larger. On the negative side, if AI's ultimate capabilities prove to be weaker than its proponents have argued, or if regulatory or technical barriers either limit the adoption of AI or make it more difficult to integrate successfully into business processes, the productivity upside could be smaller. Finally, while our estimates rely on the ultimate realization of AI-driven time savings that boost productivity, the anticipation of these gains could cause them to show up in growth statistics earlier via higher capital investment, but could subtract from the growth upside later if ultimate growth gains are over-anticipated.

Our estimates reflect a balanced consideration of these risks, and provide a template for analyzing the longer-run effects of AI on the macroeconomy. In our view, the development of capable AI is likely to be among the most consequential macroeconomic stories of the 21st century, with important implications for relative economic performance, financial market returns, and longer-run interest rates.

Joseph Briggs

Devesh Kodnani

Appendix

Detailed Summary of GDP Growth Upgrades From Generative AI (1/3)

Entity		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Argentina	*Previous*	-2.3	-0.3	1.9	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
	New	-2.3	-0.3	1.9	2.0	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.1
Australia	*Previous*	2.0	1.8	2.4	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3
	New	2.0	1.8	2.4	2.6	2.6	2.7	2.7	2.8	2.8	2.8	2.9	2.9
Brazil	*Previous*	3.0	1.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	New	3.0	1.4	2.4	2.4	2.4	2.4	2.5	2.5	2.5	2.5	2.5	2.5
Canada	*Previous*	1.3	1.7	1.9	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.3	0.4
	New	1.3	1.7	1.9	1.8	1.8	1.9	1.9	2.0	2.0	2.1	2.1	2.2
Chile	*Previous*	0.0	1.8	2.5	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	New	0.0	1.8	2.5	2.8	2.8	2.9	2.9	2.9	2.9	2.9	2.9	3.0
Mainland China	*Previous*	5.4	4.5	4.0	3.8	3.7	3.6	3.5	3.4	3.2	3.1	3.0	3.0
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2
	New	5.4	4.5	4.0	3.8	3.7	3.7	3.6	3.5	3.4	3.3	3.2	3.2
Colombia	*Previous*	1.3	1.9	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	1.3	1.9	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Czech Republic	*Previous*	0.0	3.0	4.4	2.7	2.6	2.6	2.6	2.6	2.6	2.6	2.7	2.7
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	New	0.0	3.0	4.4	2.7	2.6	2.6	2.7	2.7	2.7	2.7	2.8	2.8
Egypt	*Previous*	3.9	4.2	4.4	4.8	4.7	4.7	4.8	4.8	4.9	4.9	5.0	5.0
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	3.9	4.2	4.4	4.8	4.7	4.7	4.8	4.8	4.9	4.9	5.0	5.0
Euro Area	*Previous*	0.5	1.0	1.6	1.4	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.1
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3
	New	0.5	1.0	1.6	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4
France	*Previous*	0.9	1.1	1.3	1.3	1.3	1.1	1.1	1.1	1.1	1.1	1.1	1.1
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.2	0.3
	New	0.9	1.1	1.3	1.3	1.3	1.2	1.2	1.2	1.3	1.3	1.3	1.4
Germany	*Previous*	-0.3	0.9	1.5	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3
	New	-0.3	0.9	1.5	1.3	1.3	1.4	1.4	1.4	1.5	1.5	1.6	1.6
Ghana	*Previous*	3.1	3.4	5.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	3.1	3.4	5.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Hungary	*Previous*	-0.9	2.8	4.5	3.3	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	New	-0.9	2.8	4.5	3.3	2.8	2.9	2.9	2.9	2.9	2.9	2.9	3.0
India	*Previous*	6.4	6.3	6.7	6.6	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	6.4	6.3	6.7	6.6	6.9	6.8	6.8	6.8	6.8	6.8	6.8	6.8
Indonesia	*Previous*	5.0	4.5	4.7	4.7	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	5.0	4.5	4.7	4.7	4.6	4.6	4.6	4.6	4.6	4.6	4.6	4.6
Israel	*Previous*	3.3	3.2	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5	3.5
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.3	0.3	0.4
	New	3.3	3.2	3.5	3.5	3.5	3.7	3.7	3.7	3.8	3.8	3.9	3.9
Italy	*Previous*	0.7	0.8	1.4	1.2	1.0	0.9	0.8	0.8	0.8	0.8	0.8	0.8
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3
	New	0.7	0.8	1.4	1.2	1.0	1.0	0.9	0.9	1.0	1.0	1.1	1.1

Source: Goldman Sachs Global Investment Research

Detailed Summary of GDP Growth Upgrades From Generative AI (2/3)

Entity		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Japan	*Previous*	2.0	1.4	1.4	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	0.6
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3
	New	2.0	1.4	1.4	1.0	0.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9
Kenya	*Previous*	4.8	4.9	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	4.8	4.9	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Lebanon	*Previous*	-0.7	5.0	4.6	4.7	4.9	5.1	5.3	5.5	5.7	5.9	4.9	4.9
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	-0.7	5.0	4.6	4.7	4.9	5.1	5.3	5.5	5.7	6.0	4.9	4.9
Malaysia	*Previous*	3.8	4.3	4.0	4.1	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
	New	3.8	4.3	4.0	4.1	4.2	4.2	4.2	4.2	4.2	4.3	4.3	4.3
Mexico	*Previous*	3.0	1.7	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
	New	3.0	1.7	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.6	2.6	2.6
New Zealand	*Previous*	1.6	1.7	2.3	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3
	New	1.6	1.7	2.3	2.5	2.5	2.6	2.6	2.7	2.7	2.7	2.8	2.8
Nigeria	*Previous*	2.3	4.1	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	2.3	4.1	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8	3.8
Norway	*Previous*	1.1	0.7	1.4	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3
	New	1.1	0.7	1.4	1.6	1.5	1.6	1.6	1.6	1.7	1.7	1.8	1.8
Peru	*Previous*	-0.2	2.2	2.8	3.2	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	-0.2	2.2	2.8	3.2	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
Philippines	*Previous*	5.3	6.3	5.6	5.5	5.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	5.3	6.3	5.6	5.5	5.7	5.8	5.8	5.8	5.8	5.8	5.8	5.8
Poland	*Previous*	-0.4	3.4	5.0	3.7	3.4	3.4	3.4	3.4	3.4	3.4	3.4	3.4
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	New	-0.4	3.4	5.0	3.7	3.4	3.4	3.4	3.5	3.5	3.5	3.5	3.5
Romania	*Previous*	2.7	3.9	4.8	3.9	3.8	3.8	3.9	3.9	3.9	3.9	4.0	4.0
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
	New	2.7	3.9	4.8	3.9	3.8	3.9	3.9	3.9	4.0	4.0	4.0	4.1
Russia	*Previous*	2.0	1.5	1.2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
	New	2.0	1.5	1.2	2.0	2.0	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Saudi Arabia	*Previous*	1.5	5.1	4.6	4.2	2.7	2.7	2.1	2.1	2.1	2.1	2.1	2.1
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
	New	1.5	5.1	4.6	4.2	2.7	2.7	2.1	2.1	2.1	2.2	2.2	2.2
Singapore	*Previous*	0.8	2.5	2.2	2.2	2.3	2.3	2.2	2.1	2.0	2.0	2.0	2.0
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3
	New	0.8	2.5	2.2	2.2	2.3	2.4	2.4	2.3	2.2	2.2	2.3	2.3
South Africa	*Previous*	0.9	1.8	2.0	2.2	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
	New	0.9	1.8	2.0	2.2	2.5	2.5	2.5	2.6	2.6	2.6	2.6	2.6
South Korea	*Previous*	1.7	2.6	2.3	2.4	2.4	2.3	2.2	2.2	2.2	2.2	2.2	2.2
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.2	0.3	0.3
	New	1.7	2.6	2.3	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.5	2.5
Spain	*Previous*	2.4	1.5	2.0	1.9	1.8	1.8	1.8	1.7	1.7	1.4	1.4	1.4
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3
	New	2.4	1.5	2.0	1.9	1.8	1.9	1.9	1.9	1.9	1.6	1.7	1.7

Source: Goldman Sachs Global Investment Research

Detailed Summary of GDP Growth Upgrades From Generative AI (3/3)

Entity		2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Sweden	*Previous*	-0.7	0.1	1.9	2.2	2.0	2.2	2.3	2.3	2.2	2.1	2.1	2.1
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3
	New	-0.7	0.1	1.9	2.2	2.0	2.3	2.4	2.4	2.4	2.4	2.4	2.4
Switzerland	*Previous*	0.8	1.2	1.9	1.8	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.3	0.4	0.4
	New	0.8	1.2	1.9	1.8	1.7	1.8	1.8	1.9	1.9	2.0	2.0	2.1
Taiwan	*Previous*	1.0	2.7	2.2	2.1	2.3	2.2	2.2	2.1	2.1	2.0	2.0	2.0
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1
	New	1.0	2.7	2.2	2.1	2.3	2.3	2.2	2.2	2.1	2.1	2.1	2.1
Thailand	*Previous*	2.8	3.0	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	2.8	3.0	2.6	2.6	2.6	2.6	2.6	2.5	2.5	2.5	2.5	2.5
Turkey	*Previous*	3.0	2.7	3.5	4.0	3.4	3.7	3.8	4.1	3.6	3.6	3.5	3.5
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
	New	3.0	2.7	3.5	4.0	3.4	3.7	3.8	4.1	3.6	3.7	3.6	3.6
UK	*Previous*	0.5	0.6	1.2	1.2	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.4
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.2	0.3	0.3
	New	0.5	0.6	1.2	1.2	1.3	1.5	1.5	1.6	1.6	1.7	1.7	1.7
United Arab Emirates	*Previous*	3.0	5.0	3.5	2.2	2.2	2.2	2.2	2.2	2.3	2.3	2.3	2.3
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	New	3.0	5.0	3.5	2.2	2.2	2.2	2.3	2.3	2.3	2.4	2.4	2.4
US	*Previous*	2.2	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9	1.9
	Change	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.3	0.4	0.4	0.4
	New	2.2	1.9	1.9	1.9	2.0	2.1	2.1	2.2	2.2	2.3	2.3	2.3
Vietnam	*Previous*	4.8	6.8	6.4	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	4.8	6.8	6.4	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5	6.5
Bahrain	*Previous*	1.7	1.7	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	New	1.7	1.7	1.2	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.4	1.4
Ecuador	*Previous*	1.7	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	New	1.7	2.5	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Hong Kong	*Previous*	4.4	3.5	2.9	2.7	2.6	2.5	2.5	2.5	2.5	2.5	2.5	2.5
	Change	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.3	0.3	0.4	0.4
	New	4.4	3.5	2.9	2.7	2.6	2.7	2.7	2.7	2.8	2.8	2.9	2.9
Kuwait	*Previous*	1.4	1.4	1.4	1.4	1.4	1.0	1.0	1.0	1.0	1.0	1.0	1.0
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.2
	New	1.4	1.4	1.4	1.4	1.4	1.0	1.0	1.1	1.1	1.1	1.2	1.2
Oman	*Previous*	2.0	1.3	1.0	1.0	1.0	1.0	0.7	0.7	0.7	0.7	0.7	0.7
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1
	New	2.0	1.3	1.0	1.0	1.0	1.0	0.7	0.7	0.7	0.7	0.8	0.8
Qatar	*Previous*	0.4	2.5	17.0	8.0	1.4	0.9	0.9	0.9	0.9	0.9	0.9	0.9
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1
	New	0.4	2.5	17.0	8.0	1.4	0.9	0.9	1.0	1.0	1.0	1.1	1.1
Ukraine	*Previous*	5.5	7.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
	Change	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
	New	5.5	7.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.1

Source: Goldman Sachs Global Investment Research

Disclosure Appendix

Reg AC

We, Jan Hatzius, Joseph Briggs, Devesh Kodnani and Giovanni Pierdomenico, hereby certify that all of the views expressed in this report accurately reflect our personal views, which have not been influenced by considerations of the firm's business or client relationships.

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